IV. Spectrum showing the Ba line at 4553·4 trumpeting. Here the line, after proceeding to a considerable distance from the hottest region of the arc as a fine reversed line, gradually expands towards its extremity.

Flame-spectrum of Mn, showing the reversal of the triplet in the arc-flame.

Flame-spectra of Ca, showing the gradual extinction first of K and then of H as the flame recedes farthest from the arc.

III. Discussion of "Young's List of Chromospheric Lines." (Note I.) By J. NORMAN LOCKYER, F.R.S. Received March 5, 1879.

[PLATE 9.]

In my paper read on the 12th December, 1878, I called attention to the fact that, in the case of the metals discussed in that paper, with the exception of hydrogen, there was a considerable discrepancy between the intensities of the lines seen in our laboratories and the number of times the lines had been seen by Young in his careful researches on the chromosphere.
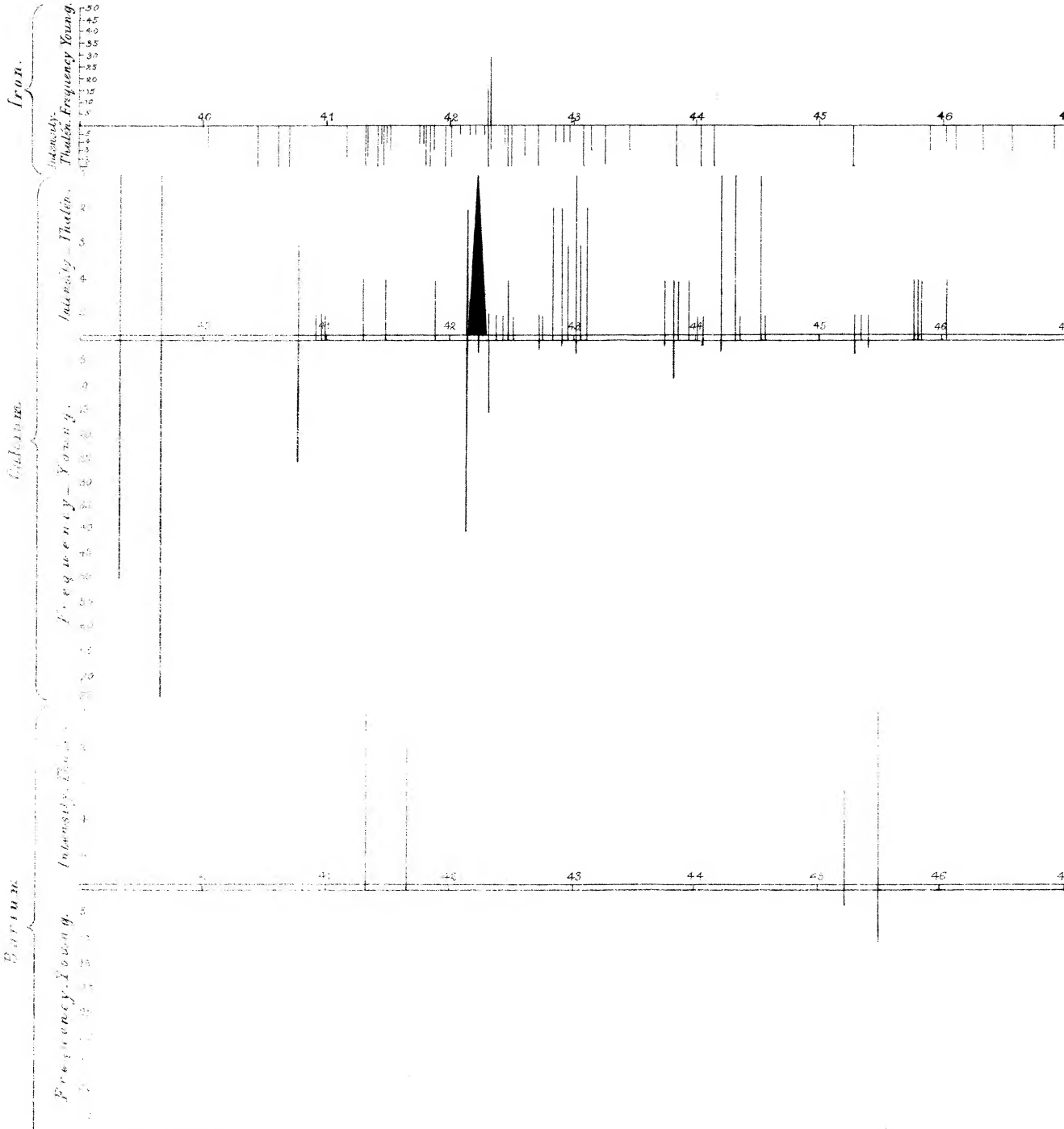
In a preliminary note " On the Substances which produce the Chromospheric Lines " I pointed out that the lines visible in the spectrum of the chromosphere when a metallic prominence is observed are for the most part basic lines, that is to say, with few exceptions, the longest and brightest lines visible in the spectra of the so-called elements are conspicuously absent; instead of them we find fainter lines, which Thalén has, in many instances, mapped as common to two elements.

Since these papers were communicated to the Society I have continued this line of inquiry, and I now propose to state what I have thus far done :—

1. The maps of the spectra of calcium, barium, iron, and manganese, submitted to the Society in an incomplete state when the preliminary note was read, have been completed. In these the lengths of the lines in the spectra of the metallic elements represent the intensities given by Thalén, whose lines and wave-lengths I have followed in all cases, while those of the lines visible in solar storms, represent the number of times each line has been seen in the spectrum of the chromosphere by Professor Young, to whose important work I have drawn special attention in my last two communications. An inspection of these maps is sufficient to show that there is no connexion whatever beyond that of wave-length between the spectra; it will be gathered from the maps how the long lines seen in our laboratories are suppressed and the feeble lines exalted in the spectrum of the chromosphere, see Plate 9. The Mn map has been omitted on account of its excessive complication.
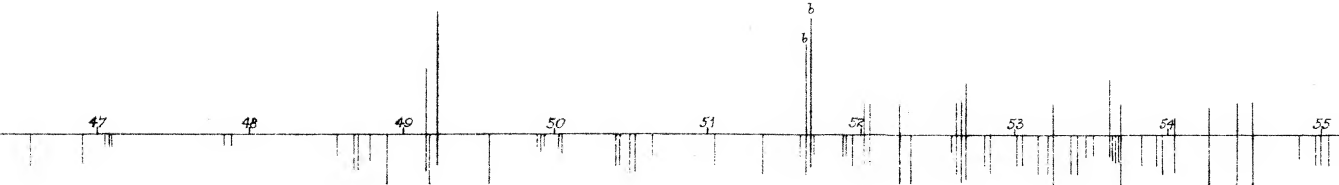
2. I have discussed the coincidences recorded in Ångström's map and Thalén tables in the sheets of the " Spectre Normal," comprising
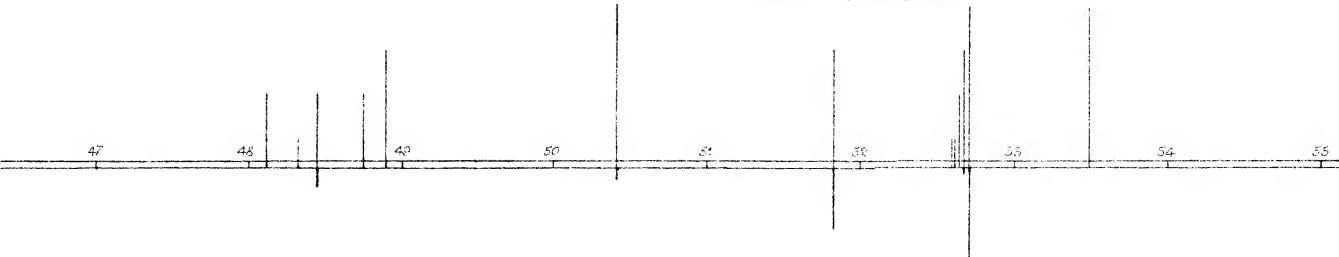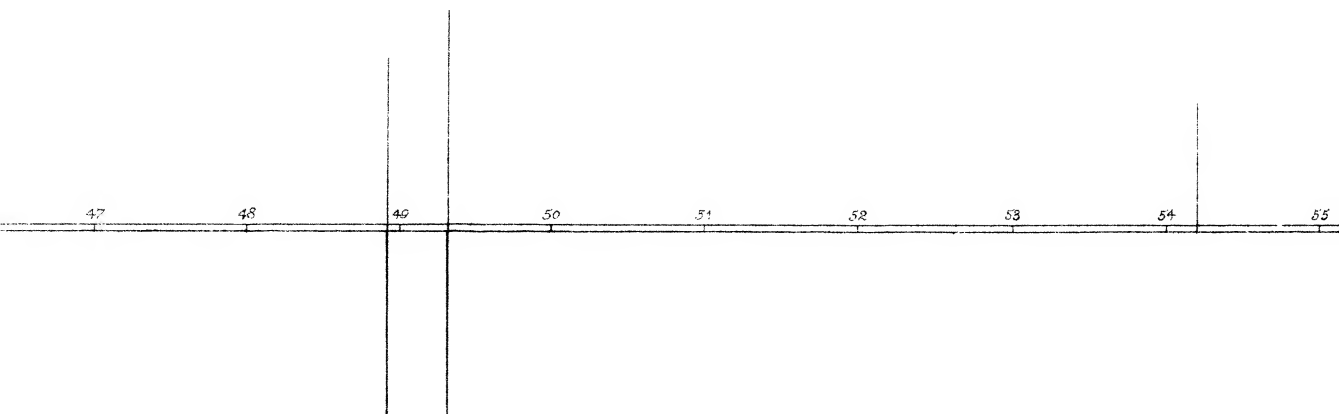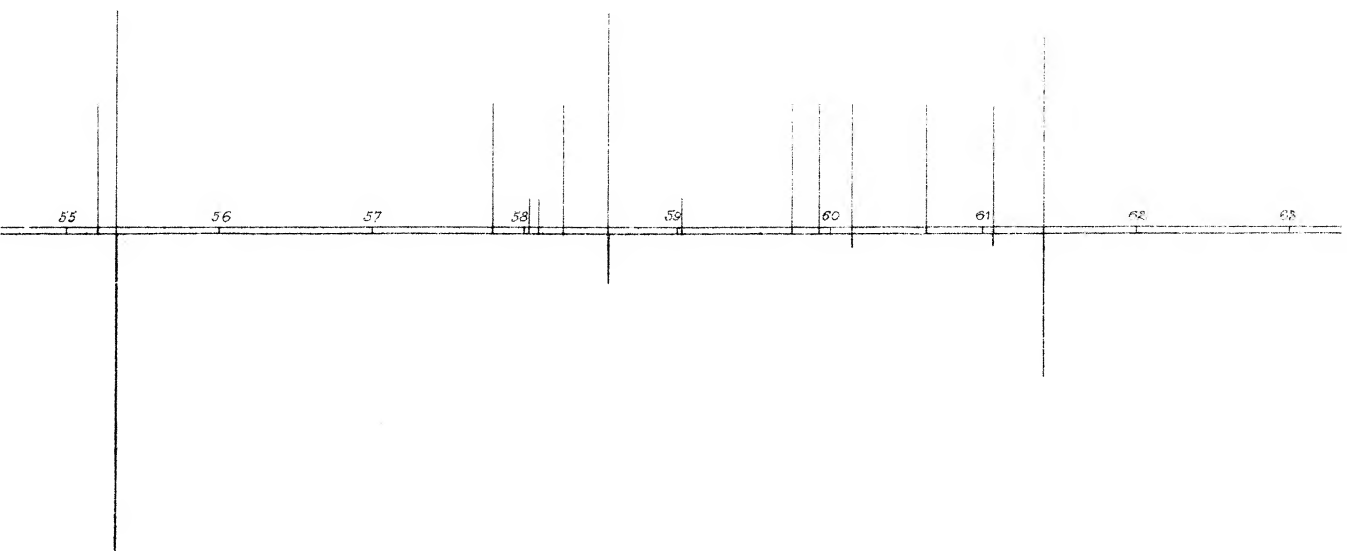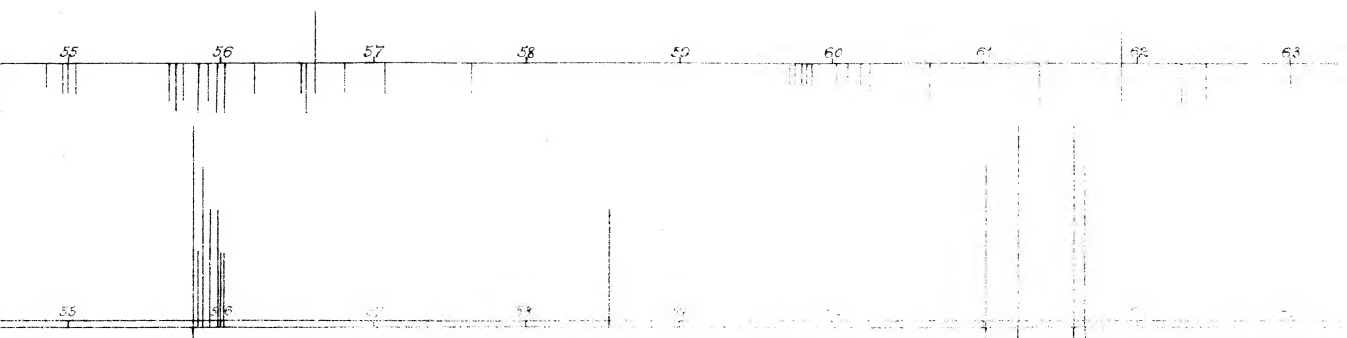
Lockyer

W H Wesley lith

I R O N .

C A L C I U M

B A R I U M .

55 56 57 58 59 60 61 62 63

55 56 57 58 59 60 61 62 63

55 56 57 58 59 60 61 62 63

63   64   65

63   64   65
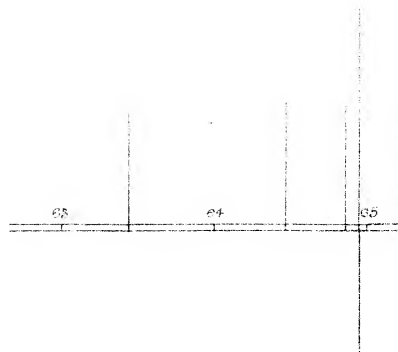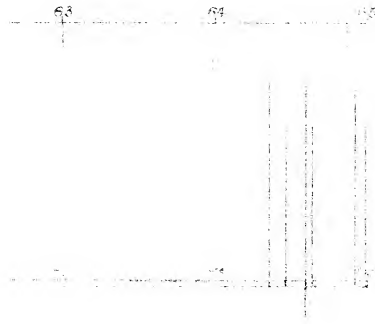
the wave-lengths 4120—5400.   I have discussed in each case the
possibility or impossibility of such coincidence having arisen from the
presence of an impurity.   Any person going over this table after he
has taken the trouble to acquire the information necessary to under-
stand it, will see that in a large number of cases the coincidences
cannot be ascribed to the existence of impurities.   In many cases, it
is true, the coincidences *may* arise from the presence of impurities,
but this is by no means a proof that they do so.   Indeed it does not
appear to have struck all who have considered this question, that, as I
have before shown, the presence of B existing with A as an impurity
and in A as a base, will, up to a certain point, give the same results ;
the ascribing of lines, therefore, to impurities, without a demonstration
of the impurity, is an unscientific proceeding.

In this table, as in the maps, it will be seen how the faintest lines
are apt to be most frequently seen in the chromosphere.   (See pp.
434—439.)

3. I have attacked Young's complete list from another point of
view, discussing, in connexion with Ångström's map and Thalén's
tables, all lines seen less than one hundred and more than fourteen
times, to determine whether, when treated in this way, there was any
connexion between the intensities of the lines, as given by Thalén,
and the number of reversals, including, of course, those cases in which
Thalén has assigned the line to two metals.

Of the forty-one lines given in the following table, no less than five
have exactly the same readings in two metals according to Thalén,
and three more have very small differences.   It will be observed that
only one line of the 1st order of intensity in the spectrum of iron
appears in the list.   This was observed three times, while two lines of
the 3rd order have been seen no less than forty times.   No line of
manganese above the 3rd order has been observed, and of the two
recorded, a 5th order line has been observed twenty times, and a 3rd
order line fifteen.

It will be seen, further, from the last column in the table, that, as a
rule, when we leave out of discussion the lines visible in Sirius, the
more intense adjacent lines of the same metals have either not been
seen at all by Young, or have been seen less frequently.   (See pp.
440, 441.)

4. I have made some preliminary observations on the presence in,
or absence from, metallic spectra of some of the lines most frequently
seen by Young, for if the lines observed so frequently by Young in
solar storms and recorded as common to two substances at least by
Thalén be really basic, it becomes highly probable that these lines are
really present in the spectra of many bodies but have been overlooked
by previous observers in consequence of their faintness.

Up to the present time my work has been somewhat restricted in this

Discussion of Metallic Coincidences in Thalén's Map.

Sheet containing E and F.

Wave-length of line and number of times seen by Young.	Intensity in Sun.	Metallic coincidences, Thalén, and Intensities.	Remarks.
5352·4 Y 4	3	5352·4 Fe (4) 5352·4 Co (3)	This is not likely to be due to an impurity of Co in Fe, as the nearest Co line (5351·2) of equal intensity is not in the Fe spectrum; neither can it be due to an impurity of Fe in Co, as the second intensity Fe line (5340·2) is absent from the Co spectrum. This, therefore, cannot arise from impurity.
5348·6	3	5348·6 Fe (4) 5348·6 Ca (2)	The second intensity Fe line 5340·2 being absent from the Ca spectrum, this cannot come from an impurity of Fe in Ca. There is not sufficient evidence in this region of the map to show that this is not due to an impurity of Ca in Fe.
5269·5 Y 15 5265·8 Y 10	2 2	5269·5 Fe (1) 5269·4 Ca (2) 5265·8 Fe (2) 5265·8 Co (3)	This line being marked considerably more intense in Fe than in Co, cannot be due to an impurity of Co in Fe; neither can it be due to an impurity of Fe in Co, as the first order Fe line at 5268·5 is absent from the Co spectrum. This line, therefore, cannot arise from impurity.
5254·1 Y 1	4	5254·1 Fe 5254·1 Mn (4)	This line is omitted from Thalén's Fe table, and is marked as a very weak line in the map; it, therefore, cannot be due to an impurity of Fe in Mn; it is not likely to be an impurity of Mn in Fe, being only a fourth intensity Mn line, the long Mn lines in other parts of the spectrum being absent from the Fe spectrum. This line is, therefore, not due to an impurity.
5234·4	5	5234·4 Fe 5234·4 Co (5)	Fe line, faint in map, is omitted from Thalén's table. Fe line of first intensity 5232·1 is not in Co spectrum; this, therefore, cannot be due to an impurity of Fe in Co. Neither can it be due to an impurity of Co in Fe, being one of the faintest Co lines, and the long Co lines in other parts of the spectrum being absent from the Fe spectrum. This line, therefore, cannot arise from impurity.

Wave-length of line and number of times seen by Young.	Intensity in Sun.	Metallic coincidences, Thalén, and Intensities.	Remarks.
5207·6 Y 10	2	5207·6 Fe (3) / 5207·6 Cr (1)	This is clearly not due to an impurity of Fe in Cr, being so much stronger in the latter metal, while the first intensity Fe lines in the same field are absent from Cr. It cannot be due to an impurity of Cr in Fe, as the Cr line of equal intensity at 5205·2 has no coincidence in the Fe spectrum. This, therefore, cannot arise from impurity.
5203·7 Y 10	2	5203·7 Fe (3) / 5203·7 Cr (1)	This coincidence cannot arise from impurity for the same reasons as last.
5168·3 Y 40	1	5168·3 Fe (3) / 5168·3 Ni (5)	This line cannot be due to an impurity of Fe in Ni, as the second order Fe line at 5138·6 is absent from Ni. There is not sufficient evidence in map to show that it is not due to an impurity of Ni in Fe.
5166·7 Y 30	1	5166·7 Fe (2) / 5166·7 Mg (1)	This line cannot be due to an impurity of Fe in Mg, as the second order Fe line at 5138·6 is absent from the Mg spectrum. Neither can it be due to an impurity of Mg in Fe, as b_1 and b_2 are absent from the spectrum of Fe.
5145·7	5	5145·7 Fe / 5145·7 Ni (5)	Fe line omitted from Thalén's table; coincidence marked in map. Cannot be due to an impurity of Fe in Ni, for the second intensity Fe line at 5138·6 is not in Ni, this line being faint in Fe. There is not sufficient evidence in this portion of the spectrum to prove that it cannot be due to an impurity of Ni in Fe ; but since in other parts of the spectrum the long Ni lines are not in Fe, it is impossible for a fifth intensity line to be present. This line, therefore, cannot arise from impurity.
5142·0	5	5142·0 Fe / 5142·0 Ni (5)	,,
5136·8	3	5136·8 Fe / 5136·8 Ni (5)	,,
5041·2 Y 2	3	5041·2 Fe (3) / 5041·2 Ca (2)	This cannot be due to an impurity of Fe in Ca as the second intensity Fe line at 5049·4 is not present in the Ca spectrum. There is not sufficient evidence to show that this line is not due to an impurity of Ca in Fe.

Wave-length of line and number of times seen by Young.	Intensity in Sun.	Metallic coincidences, Thalén, and Intensities.	Remarks.
5019·4	4	5019·4 Fe 5019·4 Ti (2)	Fe line omitted from Thalén's tables; coincidence marked in map, and the Fe line being faint cannot exist in Ti as an impurity, as the second intensity Fe line at 5049·4 is absent from the Ti spectrum. Neither can it be due to an impurity of Ti in Fe, as the first intensity Ti line at 5013·3 is absent from the Fe spectrum. This, therefore, cannot arise from impurity.
5006·6	3	5006·6 Fe 5006·6 Ti (1)	Fe line omitted from Thalén's tables; coincidence marked in map. This line being faint in Fe and of intensity 1 in Ti, it cannot be shown that it may not be due to an impurity of Ti in Fe.
4990·3	3	4990·3 Fe (4) 4990·3 Ti (1)	This cannot be due to an impurity of Fe in Ti, the first intensity Fe line 4956·7 being absent from Ti. There is not evidence enough to show that it is not due to an impurity of Ti in Fe.
4983·3	3	4983·3 Fe 4983·3 Ni (5)	Faint Fe line, omitted from Thalén's tables; coincidence shown in map cannot be due to impurity of Fe in Ni, as the first order Fe line at 4956·7 is absent from Ni; neither can it be due to Ni in Fe, as the third intensity Ni line at 5016·5 is not shown in the Fe spectrum. This, therefore, cannot arise from impurity.
4884·5	3	4884·5 Fe 4884·5 Ti (1)	Fe line omitted from Thalén's tables; coincidence marked in map. This line being faint in Fe and of intensity 1 in Ti, it cannot be shown that it may not be due to an impurity of Ti in Fe.
4877·4	2	4877·4 Fe (3) 4877·4 Ca (3)	This cannot be due to an impurity of Fe in Ca, as the first intensity Fe line at 4890·4 is not present in Ca. There are no strong Ca lines in this region, so that it cannot be shown that this may not arise from an impurity of Ca in Fe.
4839·0	5	4839·0 Fe 4839·0 Co (1)	Faint Fe line, omitted from Thalén's tables; coincidence shown in map. Cannot be impurity of Fe in Co, as it is too faint in Fe. No evidence to show that it is not due to Co in Fe.
4785·8	5	4785·8 Fe (5) 4785·8 Ni (2)	This cannot be due to an impurity of Fe in Ni, as the fourth order Fe line at 4859·2 is not in Ni; neither can it be due to an impurity of Ni in Fe, as the first order Ni line of 4713·7 is absent from the Fe spectrum. This, therefore, cannot arise from impurity.

Discussion of Metallic Coincidences in Thalén's Map.

Sheet containing G.

Wave-length of line and number of times seen by Young.	Intensity in Sun.	Metallic coincidences, Thalén, and Intensities.	Remarks.
4709·4	3	4709·4 Fe (5) / 4709·0 Ti (2)	
4690·8	3	4690·8 Fe (3) / 4690·6 Ti (2)	
4653·9	2	4653·9 Cr (4) / 4653·4 Fe (3)	
4646·4	2	4646·4 Fe / 4646·4 Cr (4)	This Fe line is omitted from Thalén's table, but is marked as a coincidence in map. This cannot be due to an impurity of Fe in Cr, as there is a third intensity Fe line at 4632·0 not in the Cr spectrum. There is not sufficient evidence to prove that it is not due to an impurity of Cr in Fe.
4585·3	3	4585·3 Fe / 4585·3 Ca (4)	Fe line omitted from Thalén's tables, but is marked as a coincidence in map. Fe line of third intensity at 4591·9 not in Ca, therefore it cannot be an impurity of Fe in Ca. Ca line of first intensity at 4454 not in Fe. This, therefore, does not arise from impurity.
4580·8	2	4580·8 Fe / 4580·8 Ca (4)	Same reasoning applies.
4578·3	4	4578·3 Fe / 4578·3 Ca (4)	,, ,,
4524·4 Y 3	3	4524·4 Fe / 4524·4 Ba (3)	This cannot be due to an impurity of Fe in Ba, for the reason that the last is not due to Fe in Ca, and it cannot be due to an impurity of Ba in Fe, for the first order Ba line at 4553·4 is not marked in the Fe spectrum.
4489·5 Y 15	3	4489·5 Fe / 4489·5 Mn (3)	Fe line omitted from Thalén's table, but coincidence marked in map. Being stronger in Mn than in Fe, it cannot be due to an impurity of the latter, and as the second order Mn lines at 4498·2, 4472·4, and 4470·5, are not marked in the Fe spectrum, it cannot be due to Mn in Fe. Therefore, this cannot arise from impurity.

Wave-length of line and number of times seen by Young.	Intensity in Sun.	Metallic coincidences, Thalén, and Intensities.	Remarks.
4426·8	3	4426·8 Fe 4426·8 Ti (1)	Fe line omitted from Thalén's tables; coincidence marked in map. Being faint in Fe and strong in Ti, it cannot be due to Fe in Ti. Neither can it be due to Ti in Fe, as the other first order Ti line at 4443·0 is not in Fe spectrum. This line, therefore, does not arise from impurity.
4414·7 Y 1	1	4414·7 Fe (1) 4414·7 Mn (2)	This line being stronger in Fe than in Mn cannot be due to an impurity of Mn in Fe. Neither can it be due to an impurity of Fe in Mn, as the equally strong Fe lines at 4404·2 and 4382·8 are not shown in the Mn spectrum. This, therefore, does not arise from impurity.
4407·7 Y 1	4	4407·7 Fe 4407·7 Ca (5)	Fe line omitted from Thalén's tables; coincidence marked in map. First order Ca line at 4425·0 not in Fe spectrum; nor first order Fe line at 4404·2 in Ca. This, therefore, does not arise from impurity.
4401·7	3	4401·7 Fe 4401·7 Ni (5)	Fe line omitted from Thalén's tables; coincidence marked in map. No strong Ni lines near.
4379·1 Y 1	4	4379·1 Ca (4) 4379·1 Fe (1)	This line cannot arise from impurity for same reasons as line at 4407·7.
4307·0 Y 3	1	4307·2 Fe (1) 4307·5 Ti (5)	
4302 Y 3	4	4302·3 Fe (4) 4302·3 Ca (1)	Fe line omitted from Thalén's tables; coincidence marked in map. Being faint in Fe and strong in Ca, it cannot be due to an impurity of Fe in Ca. The nearest long Ca line 4226·3 not in Fe spectrum; therefore this cannot arise from impurity.
4298·5	4	4298·5 Ca (3) 4298·5 Fe (4)	This line cannot be due to an impurity of Fe in Ca, as first order Fe line at 4307·2 is absent from Ca spectrum; neither can it be due to an impurity of Ca in Fe, for first order Ca line at 4302·3 is absent from Fe spectrum. This line, therefore, does not arise from impurity.
4293·8	3	4293·9 Fe (4) 4293·8 Ti (5)	
4287·0	4	4286·0 Fe (4) 4287·0 Ti (5)	In Thalén's map this is marked as a coincidence at wave-length 4287·0, while in the tables the Fe line is put down as 4286·0.
4271·5	1	4271·3 Fe (1) 4271·5 Ca (5)	

Wave-length of line and number of times seen by Young.	Intensity in Sun.	Metallic coincidences, Thalén, and Intensities.	Remarks.
4253·9	3	4253·9 Fe (5) 4253·9 Ca (5) 4253·9 Cr (1)	Fe line coincident according to map, but omitted from Thalén's tables. This line being so much more intense in Cr than in Fe or Ca, it cannot be due to an impurity of either of the last metals in Cr. It is not easy, however, to prove that it is not due to an impurity of Cr in Ca, as the other two long Cr lines in this region are also given to Ca by Thalén.
4249·8	1	4249·8 Fe (1) 4249·8 Ca (4)	This line being feeble in Ca cannot be due to an impurity of Ca in Fe, but being one of the strongest Fe lines of this region, it may or may not be due to an impurity of Fe in Ca.
4247·5	3	4247·5 Fe (4) 4247·5 Ca (5)	This line cannot be due to an impurity of Fe in Ca, as the first order Fe line at 4250·5 is not in the Ca spectrum; neither can it be due to an impurity of Ca in Fe, as the very intense Ca line at 4226·3 is not present in the Fe spectrum. This line, therefore, cannot arise from impurity.
4237·5	4	4237·5 Fe (5) 4237·5 Ca (3)	"
4233·0 Y 15	4	4233·0 Fe (3) 4233·0 Ca (5)	" Fe line omitted from Thalén's table; coincidence marked in map.
4226·8	5	4226·8 Fe (5) 4227·0 Mn (1)	This cannot arise from impurity for same reason as 4247·5.
4184·6	3	4184·6 Fe 4185·0 Ti (3)	This is a coincidence according to Thalén's map at wave-length 4184·6, while according to the tables the Ti line is 4185·0, the Fe line being omitted.
4171·0	3	4171·0 Fe 4171·0 Ti (1)	Coincidence given in map. Fe line omitted from tables. This cannot be due to an impurity of Fe in Ti, being faint in the former and strong in the latter. There is no proof that it may not be due to an impurity of Ti in Fe.
4143·1	1 or 2	4143·1 Fe (1) 4143·0 Ca (4)	There is not sufficient evidence to show that this line is not due to an impurity of Fe in Ca.
4131·5	3	4131·5 Fe (1) 4131·5 Ca (4)	It cannot be due to an impurity of Ca in Fe, being so much stronger in the latter.

Wave-length of line reversed.	No. of reversals seen by Young.	Intensity of line in Sun. (1 = darkest.)	Metallic coincidences (Thalén) and intensities. (1 = brightest.)	Nearest strong line of each metal. (1 = brightest.)	Whether observed in chromosphere. If so, how many times.
3967·9	75	1	3968·0 Ca (1)		
3932·8	50	1	3932·8 Ca (1)		
5172·0	50	1	5172·0 Mg (1)		
5183·0	50	1	5183·0 Mg (1)		
5534·1	50	4	5534·5 Ba (1) / 5533·5 Sr (2)	No long Ba line near. 5522·5 Sr (2)	No
5889·0	50	1	5889·0 Na (1)		
5895·0	50	1	5895·0 Na (1)		
4215·3	40	2 or 3	4215·3 Sr (1) / 4215·3 Ca (2)	4226·3 Ca (1)	Yes — 3
4923·1	40	3	4923·1 Fe (3) / 4923·0 Sn (4)	4956·7 Fe (1) / 4858·0 Sn (3)	Yes — 1 / No
5168·3	40	1 or 2	5168·3 Fe (3) / 5168·3 Ni (5)	5166·7 Fe (2) / 5034·6 Ni (3)	Yes — 30 / No
5525·9	40	3	Apparently belongs to Fe, but there is a mistake in either map or tables.		
4235·5	30	2	4235·5 Fe (3)	4249·8 Fe (1)	No
4245·2	30	3	Apparently belongs to Fe, but there is a mistake in map or tables.		
4899·3	30	5	4899·3 Ba (2)	4933·4 Ba (1)	Yes — 30
4921·3	30	4	None.		
4933·4	30	3	4933·4 Ba (1)	No long Ba line near. 5013·3 Ti (1)	No
5015·0	30	Not in Ångström's map.	5015·3 Ti (2)		No
5017·6	30	2	None.	5172·0 Mg (1)	Yes — 50
5166·7	30	1	5166·7 Mg (1) / 5166·7 Fe (2)	5226·2 Fe (1)	Yes — 10
5275·0	30	3	None.		

Wave-length of line reversed.	No. of reversals seen by Young.	Intensity of line in Sun.	Metallic coincidences (Thalén) and intensities.	Nearest strong line of each metal.	Whether observed in chromosphere. If so, how many times.	
4077·0	25	1 = darkest.	1 = brightest. 4077 Ca. (3)	1 = brightest. 3968·0 Ca (1)	Yes	75
5424·5	25	3	5425·0 Ti (3) / 5425·0 Ba (3)	5428·6 Ti (2) / 5534·5 Ba (1)	5428·8 / 5534·1	8 / 50
6140·6	25	Not in Ångström's map.	6140·6 Ba (1)	No long Ba line near.		
6676·9	25	2	None.		Yes	10
4468·5	20	5	4468·5 Ti (1)	4443·0 Ti (1)	No	
4490·9	20	3	4491·0 Mn (5)	4498·2 Mn (2)	No	
4918·2	20	5	4918·2 Fe (2)	4919·8 Fe (1)	No	
5283·4	20	2 Not in Ångström's map.	5282·8 Ti (1)?	5296·7 Ti (1)		
5361·9	20	3	5361·9 Fe (4)	5370·5 Fe (1)	Yes	10
6429·9	20	··	Not in Thalén's tables.		Yes	3
4233·0	15	4	4233·0 Ca (5) / 4233·0 Fe (3)	4226·3 Ca (1) / 4249·8 Fe (1)	No	
4394·6	15	4	None.		No	
4489·4	15	4	4489·5 Mn (3)	4498·2 Mn (2)	No	
4500·3	15	2	Marked in map as Fe also, but not in Thalén's tables. 4500·7 Ti (1)	4526·1 Ti (1)	No	
4583·2	15	3	None.			
4629·0	15	3	4629·0 Ti (3)	4638·8 Ti (1)	No	
5197·0	15	5	None.	5268·5 Fe (1)	Yes	12
5269·5	15	2	5269·5 Fe (1) / 5269·4 Ca. (2)	5348·6 Ca (2)	No	
5518·7	15	4	This seems to be a Ba line, but there is a mistake in tables or map.		No	
5661·5	15	3	5661·5 Fe (3)	5657·6 Fe (1)	No	
6515·5	15	2	None.			

direction, since, as I have been anxious to avoid any question arising from the known impurity of carbon poles, I have limited myself to the use of double metallic poles or experimented on very volatile substances, the impurities carried up by which are easily detected.   I append a provisional table of the results I have already obtained.   I do not hold to its absolute accuracy, but I know it is sound in the main.   (See p. 443.)

The dispersion I have employed (Rutherford's grating, 17,000 lines second order) has been so great that the observations would have been more satisfactory if the light of the arc had been less reduced by dispersion.   We may therefore feel assured that we are dealing with lines of the same wave-length, identical, that is, within the range of the most powerful instrumental methods ordinarily employed. In all cases a battery of thirty Grove cells was used, and the lines were successively observed at the intersection of two cross-wires in the field of view, everything remained unchanged and rigid except the poles between which the arc was made to pass.   For the lines between H and G an inspection of photographs has taken the place of eye observations, and for this not only my own series of photographs has been used, but a most valuable one placed at my disposal by Professor Roscoe.

The list in its present very incomplete state leads to very remarkable conclusions; the line at 1474 has been found in several spectra, while Lorenzoni's f is markedly absent from the spectra of forty-two metallic elements ; this result, I think, justifies the suspicion long ago stated that f belongs to the same substance, or at least is nearly related to that which produces D_3.   It will be seen too that a line coincident with the h line of hydrogen has been photographed in the spectra of several substances besides indium, G being absent, and F also, as I have gathered from an inspection of Dr. Roscoe's photographs.   I may add that I have reason to suspect the existence of the C line alone in the spectra of some chemical substances.

These observations have compelled me to make rapid surveys of the arc-spectra of most of the metallic elements, and have again brought to the front, in a very striking way, the view I expressed to the Royal Society some five or six years ago, that many of the lines in line-spectra are the brightest portions—the remnants—of flutings and possibly of other rhythmic structure.   I am at present engaged in investigating this question of rhythm, and I have already found that many of the first order lines of iron may probably arise from the superposition or integration of a number of rhythmical triplets.   All this goes to show how long the series of simplifications is that we bring about in the case of the so-called elementary bodies by the application of a temperature that we cannot as yet define.   Indeed the more one studies spectra in detail, and especially under varying

Table showing certain Basic Lines.

Element	5269	6140·6	4933	5534·1	5315·9 "1474"	5183 b_1	5172 b_2	5168·3 b_3	5166·7 b_4	4361 F	4471 f	4340 G	4010 h
No. of times given by Young	15	25	30	50	90	50	50	40	30	100	100	100	100
Ce, La, Di								−	−	+	−	−	+
In	+		+	+	+				−	−	−	−	+
Ru					+				+	−	−	p	+
Sn					+				+	−	−	p	+
U				+	+				+	−	−	+	−
Fe	+	+	+	+					+	−	−	−	−
Mo	+	+	+	+					+	−	−	−	−
W				+					+	−	−	−	i
Co	+		+	+	+				d	−	−	−	−
Mn	+	+	+	+				+	p	−	−	−	−
Ca		+	+	+	+				+	−	−	−	−
Li									+	−	−	−	−
Na										−	−	−	−
Cu										−	−	−	−
Al										−	−	−	−
Ba										−	−	−	−
Sr										−	−	−	−
Au										−	−	−	−
Ag										−	−	−	−
Ti	+	+		+						−	−	−	−
Ni										−	−	−	−
Cr										−	−	−	−
Sb										−	−	−	−
As										−	−	−	−
Bi										−	−	−	−
Pt										−	−	−	−
Cs										−	−	−	−
Gl										−	−	−	−
Ir										−	−	−	−
Pb										−	−	+	−
Mg					+++	+	+	+	+	−	−	−	−
Yt										−	−	−	−
Er										−	−	−	−
Os										−	−	−	−
Pd										−	−	−	−
K										−	−	−	−
Rb										−	−	−	−
Tl										−	−	−	−
Sn										−	−	−	−
U										−	−	−	−
Va										−	−	−	−
Zn										−	−	−	−
Hg										−	−	−	−
Ru										−	−	−	−
Rh										−	−	−	−
Ta										−	−	−	−
Zr										−	−	−	−
Nb										−	−	−	−
Th										−	−	−	−

+ means present.   − means absent.   p means probable.   d means doubtful.

conditions of temperature which enable us to observe the reversal now of this set of lines, now of that, the more complex becomes the possible origin. Some spectra are full of doublets: sodium and potassium, as ordinarily mapped, may be said indeed to consist exclusively of doublets; others, again, are full of triplets, the wider member being sometimes on the more, sometimes on the less, refrangible side. Doublets and triplets, as a rule, reverse themselves more freely than the irregular lines in the same spectrum—which particular doublet or triplet will reverse depending upon the temperature, as if the cooler vapour to which the reversal is due varied as in the case of fractional distillation. Some lines are clean cut in their reversal; others, again, to use the laboratory phrase, are fluffy to a degree that must be seen to be appreciated, so much so, that when photographed they appear merely as blurs upon the plate.

The above results, which have been foreshadowed in my previous papers, have led me to examine especially the intensities of the various Fraunhofer lines, and to compare the intensities of the metallic lines confronted with them in arc and sun photographs. I have done this because it is worse than useless to proceed with this construction of the large map now that four years' work has shown that the method of impurity elimination has proved insufficient, until some other method, embodying a higher law, can be used; and to get this we want work over the whole field. This examination I am making, not only from K to G, over which my own photographs extend, but even to b, by means of another series taken by Professor Roscoe, which he has allowed me to inspect.

In short, in this survey I have about 300 photographs to work upon. I exhibit several of these photographs to the Society in anticipation of a further communication.

The upshot of this inquiry even already is as follows:—The discrepancy which I pointed out, six years ago, between the solar and terrestrial spectra of calcium is not an exceptional, but truly a typical case. Variations of the same kind stare us in the face when the *minute anatomy* of the spectrum of almost every one of the so-called elements is studied. If, therefore, the argument for the existence of our terrestrial elements in extra-terrestrial bodies, including the sun, is to depend upon the perfect matching of the wave-lengths and intensities of the metallic and Fraunhofer lines, then we are driven to the conclusion that THE ELEMENTS WITH WHICH WE ARE ACQUAINTED HERE DO NOT EXIST IN THE SUN.